Effective Accuracy of Satellite Predicted Irradiance

Richard Perez, Antoine Zelenka and David Renné

Estimates of hourly global irradiance based upon geostationary satellite data with a ground resolution of a few kilometers reproduce ground-measured value with a relative Root Mean Square Error (RMSE) of typically 20-25%. However, this "observed" RMSE does not represent the intrinsic accuracy of satellite data-to-irradiance conversion models. Indeed, much of this RMSE results from the difference between a time integrated, point-specific measurement—the ground-measured irradiance– and a time specific, spatially (pixel-wide) integrated measurement—the satellite-derived irradiance.

We present quantitative estimates of the respective contribution of each component—intrinsic satellite model error, point-pixel discrepancy and ground measurement inaccuracy —amounting to the observed "conventional" RMSE. This presentation is made from the standpoint of a user having to rely on site/time specific data. From such a standpoint, the intrinsic or "effective" RMSE of satellite-derived irradiance is estimated to be of the order of 12%.

EFFECTIVE ACCURACY OF SATELLITE-DERIVED IRRADIANCE

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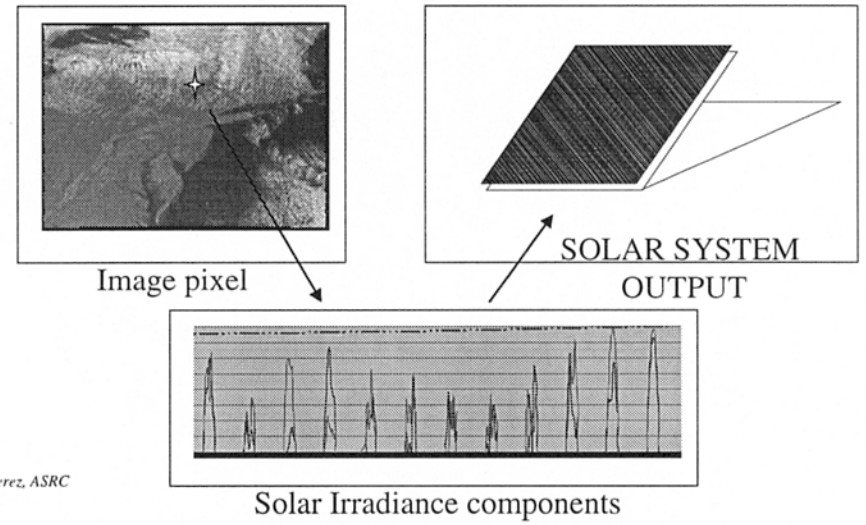
How precise ?

Site/time-specific data
Site-specific statistics



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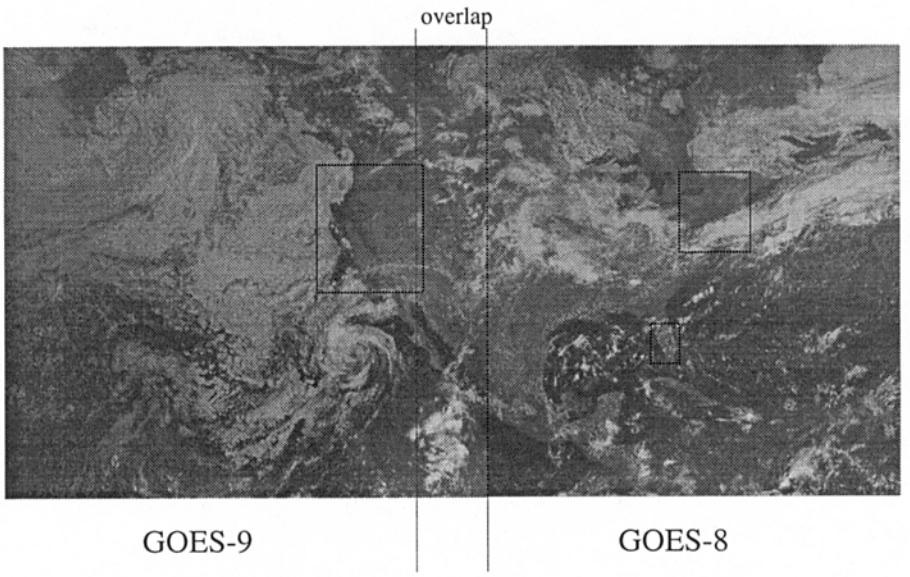
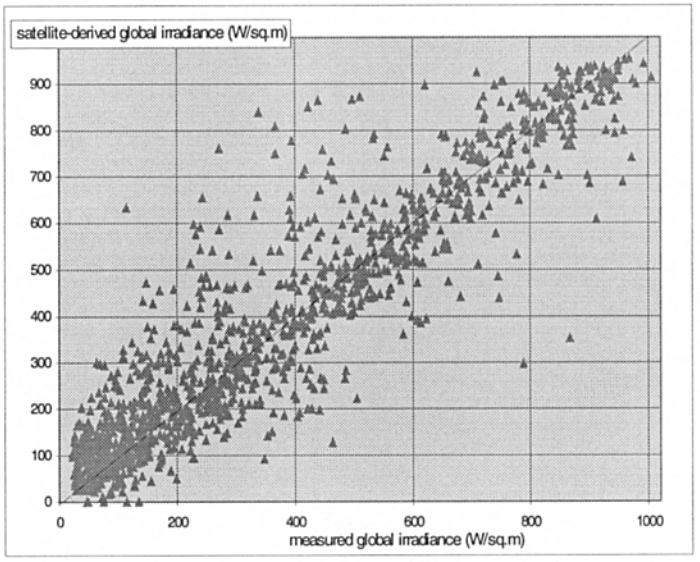


Re-gridded GOES images archived at ASRC

Perez et al.

Perez et al., ASRC



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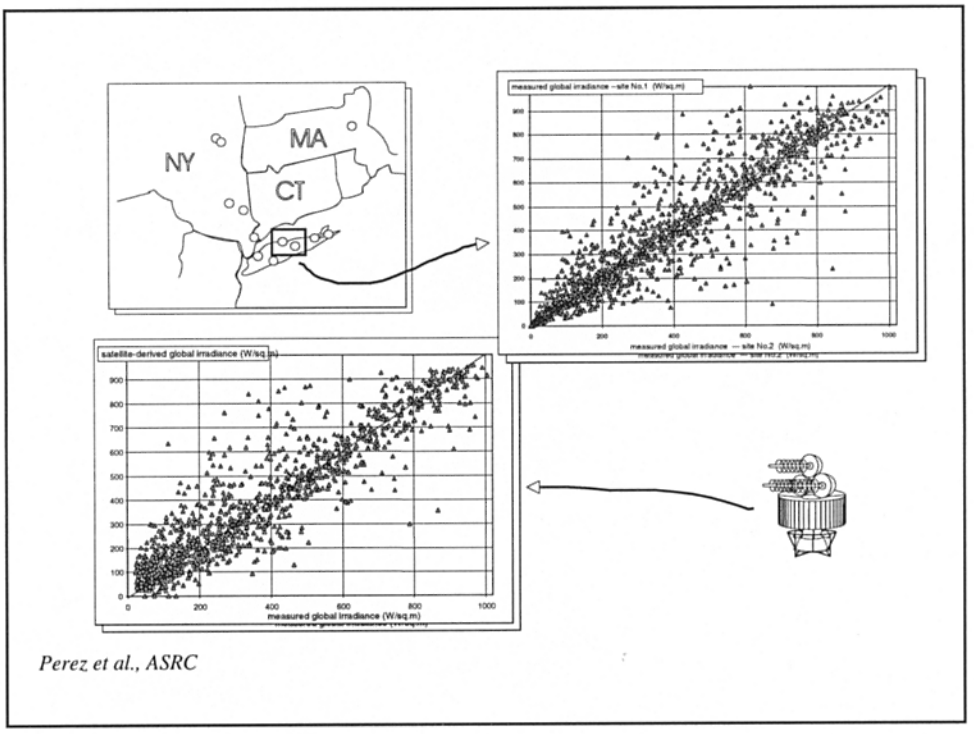

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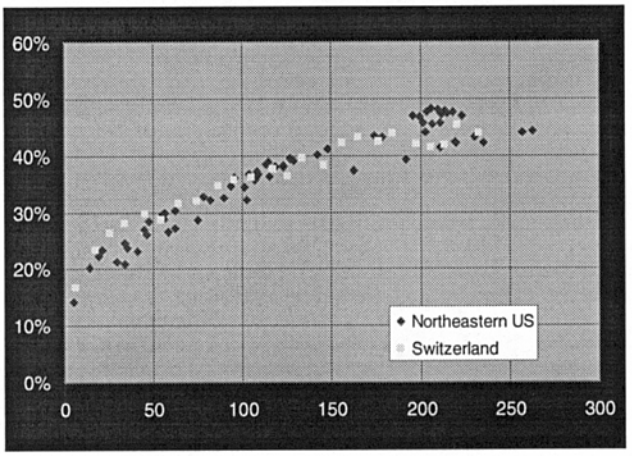
Hourly RMS Error as a function of station distance

satellite becomes more accurate beyond 15 km



Satellite's Effective Accuracy ~ 6 %

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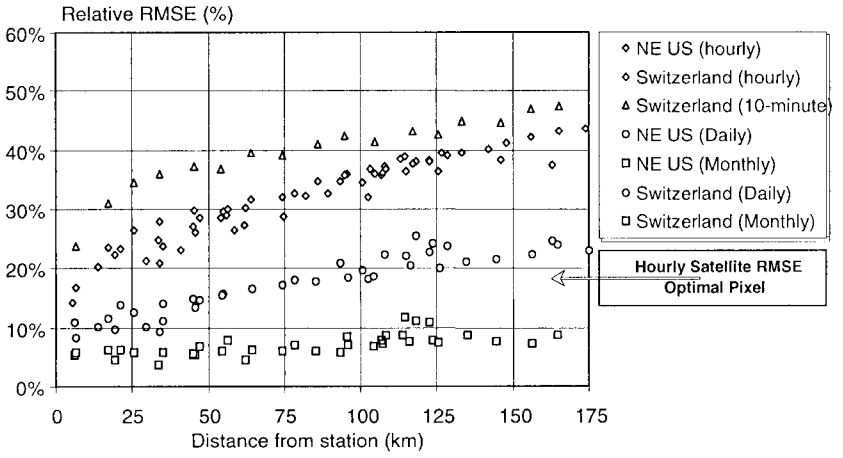
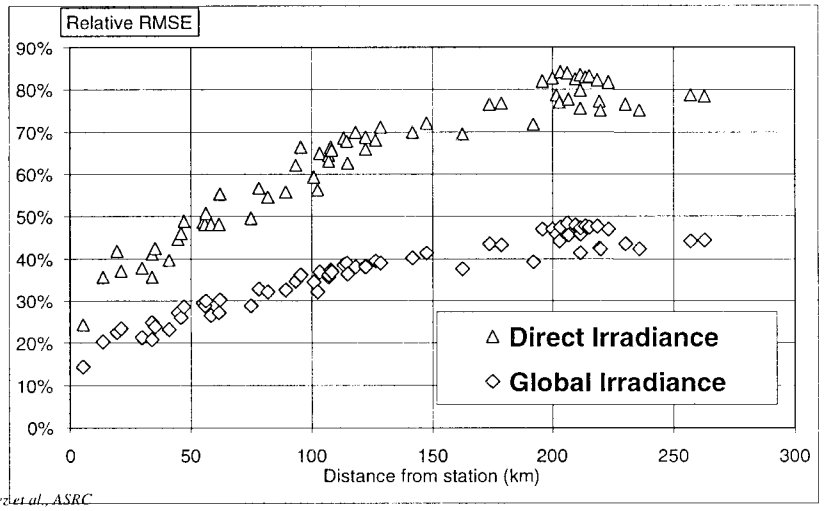
10-min, Hourly, Daily and Monthly Extrapolation RMSE as a function of station distance



Hourly Global and Direct Irradiance Extrapolation RMSE as a function of station distance



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EXPERIMENTAL DETERMINATION OF EFFECTIVE ACCURACY

- CLOUD FRACTAL SELF SIMILARITY ASSUMPTION
- LOCALLY HOMOGENEOUS CONDITIONS

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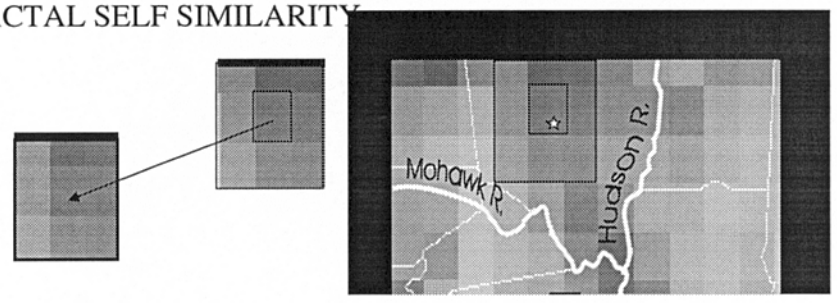
Experimental determination of Effective Accuracy FRACTAL SELF SIMILARITY



Fractal self similarity suggests that:

Irradiance observed by at some point within a pixel will be found at a larger spatial scale in a neighboring pixel

Hence an experimental measure of effective accuracy is

$RMSE_{eff} = (\Sigma (station - pixel^*))^{1/2}$

where pixel = any 1 of 9 pixels, whichever happens to be most accurate at a any given point in time*

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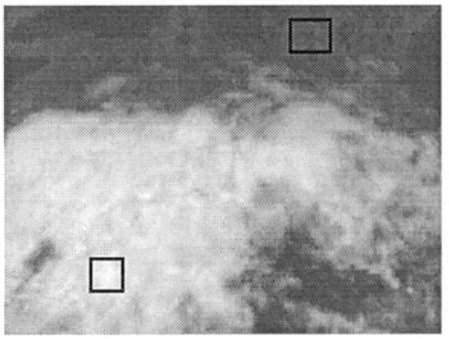
Experimental determination of Effective Accuracy
LOCALLY HOMOGENEOUS CONDITIONS



$$RMSE_{eff} = (\Sigma (station - pixel^*))^{1/2}$$

where pixel = Closest pixel, but only considered when neighbors are within ± 5 %*

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EXPERIMENTAL DETERMINATION OF EFFECTIVE ACCURACY

- CLOUD FRACTAL SELF SIMILARITY ASSUMPTION
- LOCALLY HOMOGENEOUS CONDITIONS

ground truth site	"classical" closest pixel RMSE	self-similarity effective RMSE	homogeneous effective RMSE
New Paltz (NY)	22%	11%	14%
waltham (Mass)	21%	12%	14%
Mc Arthur (NY-LI)	20%	10%	13%
Albany	23%	11%	17%
All sites	**22%**	**11%**	**15%**

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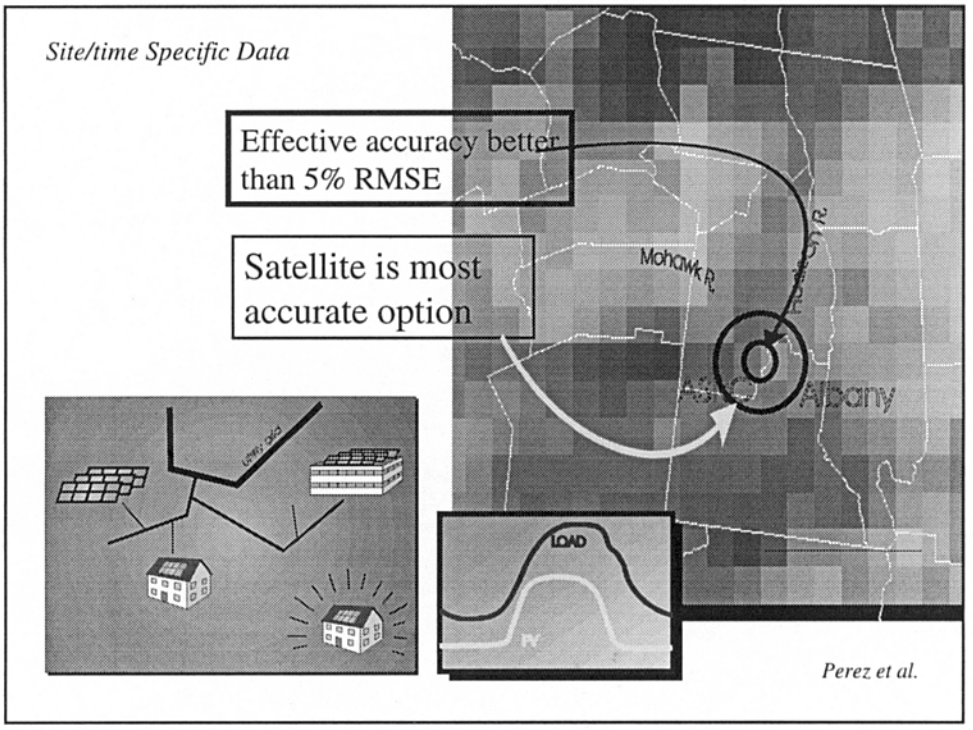

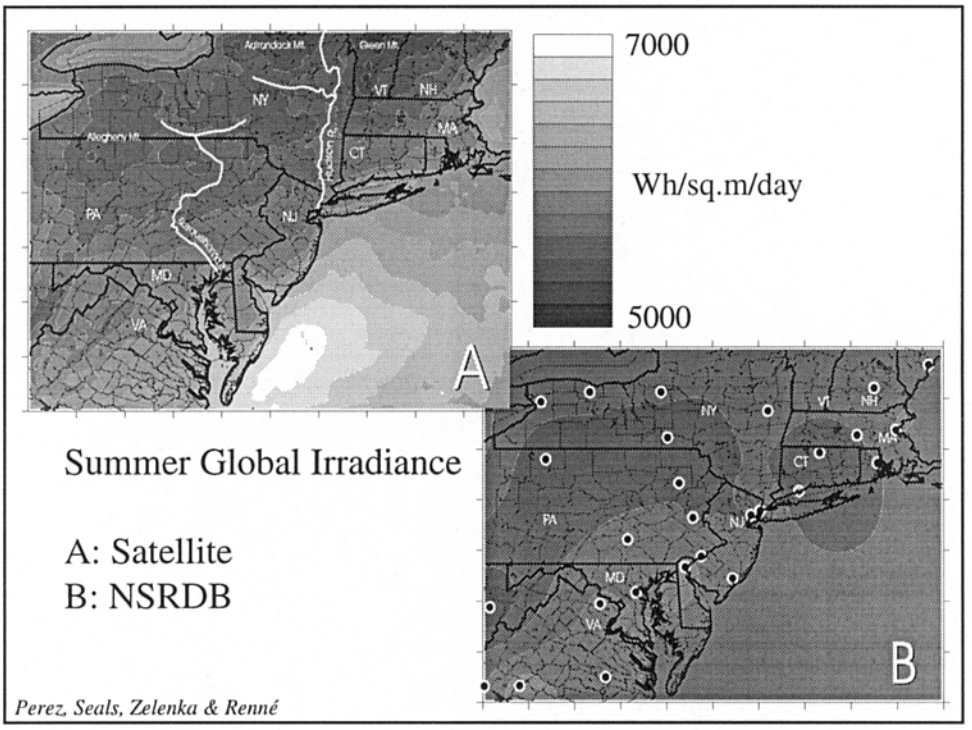

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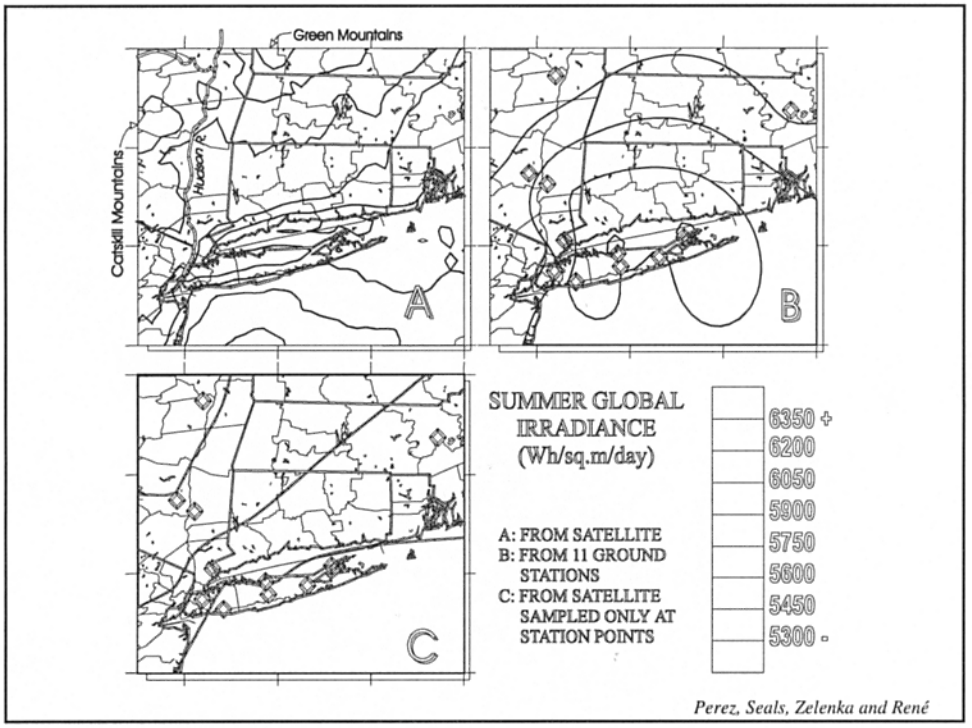

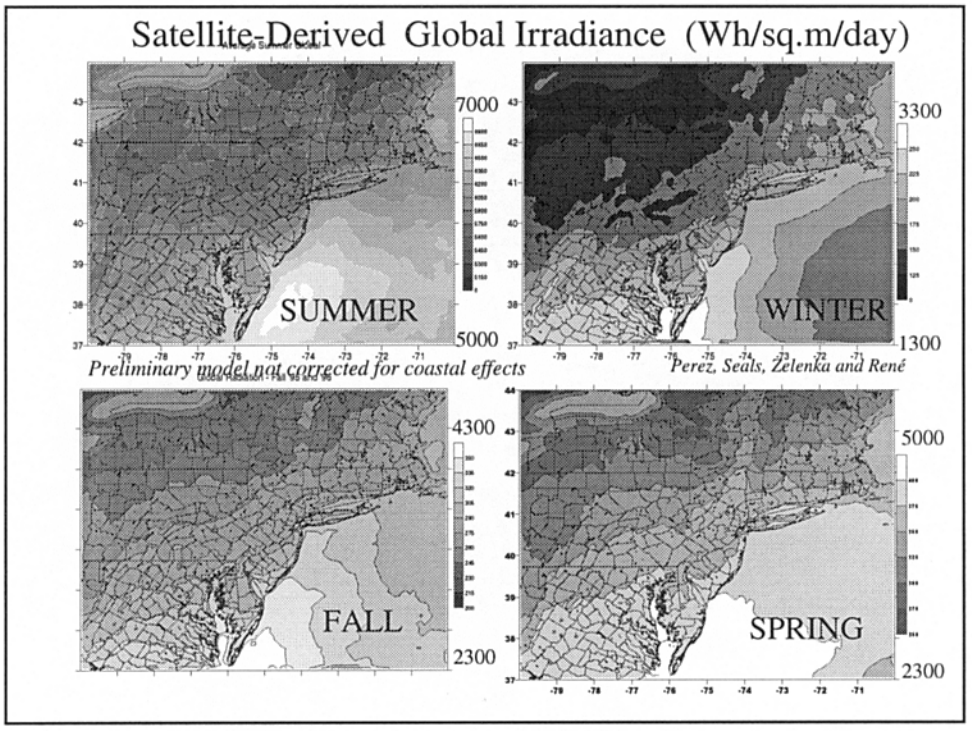

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CONCLUSIONS

Predicting site-time specific irradiance

- Although point-specific precision may never be better than 20-25%
- Pixel-wide precision (5X5 km) is more likely of the order of 10-15%
  - Impact on ground truth investigations
  - Increased acceptability for solar energy investigations
- Conclusion is reached using very simple model

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